

# Microbiological Safety of Street Vended Foods in Mahendranagar, Farwestern Nepal

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## ABSTRACT:

Food safety problems are particularly becoming an increasingly serious threat to public health in developing countries. Microbial contamination of ready-to-eat foods sold by street vendors has become a global health problem. This study was conducted to assess microbiological safety of street vended foods from March to August, 2017 in Mahendranagar bazar. A cross-sectional design was used to answer questions concerning the current status of food hygiene and sanitation practice of street food vending sites. Interview and observational assessments were used to collect socio-demographic data about street food vendors. Seventy one samples of street foods were aseptically collected from different six location of Mahendranagar bazar. The samples were analyzed by standard procedures within an hour of procurement. Both descriptive and analytical statistical methods were applied. The majority of the street food vendors were men, 53(75%), with the average age group of 31–40 years (48%) and mean age was 37 years. Twenty six (36%) street vendors were illiterate while rest of them received formal education up to secondary level. The majority 50 (70%) of vendors prepare food at home and 60 (85%) were mobile stall. All vendors had not any formal training and did not follow any food safety and personnel hygiene during food preparation and serving. Analysis of the food samples revealed high loads of bacterial pathogens such as total bacterial count, lactic acid bacteria, coliforms, *Staphylococcus aureus*, *Bacillus cereus*, *Salmonella* spp. and yeast. Total bacterial count in all the samples varied between 6.5 to 8.4 log cfu/g, LAB count were 0.8 to 5.2 log cfu/g, coliforms between 2.1 to 5.2 log cfu/g, *Bacillus* between 3.0 to 7.2 log cfu/g, *Staphylococcus aureus* was detected in all samples except vegetable momo and vegetable chaumein varies 0.6 to 5.0 log cfu/g. *Salmonella* spp. was also found in chicken momo and somosa. The yeast contamination was also found in all food samples except somosa and bread chop within the range 1.5 to 3.8 log cfu/g. This study revealed that there is a reasonable gap on food safety knowledge among street food vendors. The microbial profile was also higher compared to standards set by the World Health Organization. Due attention should be given by the government to improve knowledge about food safety and the quality standard of street foods sold in the city.

**Keywords:** Bacteria, Food safety, Street vended foods, Mahendranagar, Microorganism

## INTRODUCTION:

Street foods are ready-to-eat foods prepared and/or sold by vendors in public places [1]. Street foods ensure food security for low-income group urban populations [2, 3]. It is consumed each day by an estimated 2.5 billion people worldwide [4]. Microbial contamination of ready-to-eat foods and beverages sold by street vendors has become a global health problem. Vendors are often with no formal education, untrained in food hygiene, and work under crude and unsanitary conditions and have no or very little knowledge about the cause of food-borne diseases [5]. Irrespective of its health effects, people consume street foods in day-to-day life which are sold in the streets, public places, busy market places, school areas, near college

campuses, and taxi stands, etc. [6]. Millions of people consume snacks, meals and drinks sold by street vendors in the developing countries [7]. The street foods have not only been limited within low income people but people from various walks of life have been found to relish street food.

Street food appears to be on the rise encouraged by growing urban populations and public demand for readily available cheap food. However, the generally unregulated street food tends to observe poor hygienic practices and breed significant public health problems [8]. At various times street foods have been found to harbor organisms responsible for causing typhoid, brucellosis, food poisoning, dysentery and

diarrhea. Therefore, there is high potential health risk associated with initial contamination of foods by pathogenic bacteria as well as subsequent contamination by vendors during preparation, handling, and cross contamination [9].

Kancharpur district is province no. 7 of the Nepal, 5 km east of the Indian border and 700 km west of Kathmandu. It covers an area of 1,610 km<sup>2</sup> and had population 451,248 [10]. The growing population of dwellers in Kanchanpur has increased the demand for street food and as such there has been increase in the number and varieties of food sold by the vendors. Common ethnic street foods of kanchanur are samosa, kachori, alu chop, vegetable momo, chicken momo, alu-cheura, vegetable chow- mein, pani puri, alu tikki, vegetable momo, mutton momo, bread chop, vegetable chowmein, and vegetable

pakoda. This paper aimed to assess the microorganisms present in the ethnic street foods and socio demography of vendors in Kanchanpur.

### Materials and Methods

The present study was carried out by starting with survey of street food centers to gather location of street food centers, type of street foods sold, and to get the first hand information on the hygiene and sanitation conditions followed. The varieties of foods selling in the different street food centers in different areas are breakfast items, meals items, snack items and staple. Among the all categories, snack items and staple are which are commonly consumed and sold items were taken for analysis. The items taken for microbial analysis from each category were given as follows.

Table 1 Ethnic street food of Mahendranagar

Street food	Ingredient	Nature of food
Vegetable momo	Flour, cabbage, monosodium glutamate, onion, spices, salt	Steamed :staple
Chicken momo	Flour, chicken, monosodium glutamate, onion, spices, salt	Steamed: staple
Somosa	Flour, potato, onion, pea, spice, oil, salt	Deep fried: staple
Bread chop	Bread, gram flour, oil	Deep fried: snack
Vegetable chaumein	Flour, different types of vegetable onion, gram, oil, spice, salt	Shallow fried: snack/staple
Chicken chaumein	Flour, chicken, onion, gram, oil, spice, salt	Shallow fried: snack/staple
Chhola	Potato, gram, pea, onion, spice, salt, oil, water, curd	Cooked: snack
Panipuri	Flour, spice, salt, oil, water	Deep fried: clip
Alu tika	Flour, potato, pea, spice, salt, oil	Shallow fried: snack/staple
Chana chatpat	Gram, onion, spice, salt, oil	Fried: snack
Egg	Boiled egg, gram flour, oil	Shallow fried: staple

Table 2 Characteristics of street food vendors in Mahendranagar town (N=71)

Attribute		Frequencies
Age	21-30	13 (18%)
	31-40	34 (48%)
	41-50	24 (34%)
Sex	Male	53 (75%)
	Female	18 (25%)
Education attainment	None	26 (37%)
	Primary	37 (52%)
	Secondary	8 (11%)
Types of vender	Stationary	60 (85%)
	Mobile	11 (15%)
Place of preparation of food	At home	27 (38%)
	At stall	44 (62%)
Food vending knowledge acquisition	Self taught	50 (70%)
	Taught by parents	21 (30%)
	Formal training	0 (0%)
Knowledge of food Handling		Frequencies
Raw food material washed before cooking	Yes	37 (52%)
	NO	34 (48%)
Clean the preparation surface before reuse	Yes	48 (68%)
	No	23 (32%)
Use apron, gloves and hair covering	Yes	0 (0%)
	No	71 (100%)
Reuse oil	Yes	53 (75%)
	No	18 (25%)

Table 3 Microbial profile of street vended food sold at Mahendranagar

Street foods	Microbial load (log cfu/g sample)						
	LAB	Bacilli	Coliform	Staphylococcus	Salmonella	Yeast	TVC
Vegetable Momo n=7	2.8±0.06	3.0±0.06	5.2±0.01	<DL	<DL	3.2±0.04	7.0±0.06
Chicken Momo n=9	5.2±0.03	7.1±0.04	4.7±0.0	3.1±0.05	2.1±0.02	1.5±0.0	7.3±0.02
Somasa n=10	0.9±0.03	7.2±0.05	5.1±0.06	3.4±0.02	0.5±0.01	<DL	8.4±0.06
Bread Chop N=13	2.4±0.03	5.3±0.06	4.8±0.03	4.0±0.03	<DL	<DL	6.5±0.0
Veg. chaumein n=11	0.8±0.03	3.8±0.05	3.8±0.01	<LD	<LD	3.8±0.04	7.4±0.0
Panipuri n=15	<LD	7.2±0.06	2.1±0.03	5.0±0.06	<LD	3.8±0.04	7.4±0.03
Alu Tika n=13	2.3±0.04	3.8±0.04	4.2±0.04	0.6±0.06	<LD	2.0±0.04	6.8±0.0

Data represents the means ( $\pm$  standard deviation) of number of samples. Each sample was analyzed in duplicate. DL, less than detection limit (10c fu/g); LAB, lactic acid bacteria; TVC, total viable count.

### 1. Study Design and Study Area

A cross-sectional study was conducted street vendors and fast-food outlets in Mahendranagar town from March to August 2017.

### 2. Collection of Samples

All street vendors and fast-food outlets included in Mahendranagar bazar area were chosen for the collection of samples. Each sample was collected twice from all street food centers with 15 days interval period. Establishments with permanent building were excluded from the study. All the samples were aseptically collected in sterile containers, stored at 4°C and analyzed within an hour of procurement. Samples of street foods of vegetable momo, chicken momo, somosa, bread chop, vegetable chaumein, chicken chaumein, panipuri, alu tika were collected directly from different markets of Mahendranagar. Samples were collected aseptically in pre sterile poly-bags and sterile bottles, kept in ice-boxes and labeled. Samples were then transferred to the laboratory and stored at 4°C until analysis. Samples were taken out from freezer and were analyzed when the temperature of the samples were at room temperature.

### 3. Sample Processing for Analysis

Ten grams of sample was weighed under aseptic condition, homogenized with 90ml of sterile distilled water by using motor and piston. Serial dilutions were prepared and spread plate technique was used on appropriate selective media.

### 4. Microbial Analysis

The selected food items for microbial analysis were brought into the laboratory under aseptic conditions, analyzed for total plate count (TPC) on standard plate count agar (PCA), coliforms on violet red bile agar (VRBA), *Bacillus cereus* on Mannitol egg yolk polymyxin agar (MYPA)

*Staphylococcus* in Manitol salt agar (MSA), *Salmonella* on Bismuth sulphite agar and Yeast and Moulds on Potato dextrose agar (PDA). The standard procedure [11] was followed for microbial analysis with above respective media. All plates were incubated under aerobic conditions at 37°C for 24- 72 hrs. Isolates were gram stained and tested for catalase production, and were preliminarily identified based on the phenotypic properties such as carbon dioxide production from glucose, ammonia production from arginine, growth at different temperatures, as well as the ability to grow in different concentrations of sodium chloride and pH based on the method of Schillinger and Lücke [12]. Vogese Proskauer test, nitrate reduction, starch hydrolysis, casein hydrolysis, citrate utilization test, bile salt tolerance, and anaerobic growth were determined for characterization of *Bacillus* [13, 14].

### 5. Statistical Analysis

Both descriptive and analytical statistical methods were applied. Data were entered and analyzed using Microsoft Excel version 2007.

### 6. Ethical Considerations

Informed written consent was also obtained from each study participant after explaining the objective of the study. All the information about the study participants was kept confidential.

### RESULTS AND DISCUSSION:

Street food appears to be on the rise encouraged by growing urban populations and public demand for readily available cheap food. However, the generally unregulated street food tends to observe poor hygienic practices and breed significant public health problems [15]. At various times street foods have been found to harbor organisms responsible for causing typhoid, brucellosis, food poisoning, dysentery and diarrhea. The

street vendors are mostly uninformed of good hygiene practices, which can increase the risk of street food contamination [16]. Therefore, there is high potential health risk associated with initial contamination of foods by pathogenic bacteria as well as subsequent contamination by vendors during preparation, handling, and cross contamination [17].

### 1. Socio-Demographic Profile of Respondents:

In this study, majority of the street food vendors were men, 53(75%) with the average age group of 31–40 years (48%) and with mean age of 37 years. Muinde and Kuria in their study in Nairobi, Kenya, found that over 35% of the vendors belonged to the age category of 20–25 years. Sixty percent of the vendors were males while 40% were females [18]. We found majority 73 (52%) of the respondents had received primary and 37% were illiterate while the rest 8(11%) received secondary level of education. About 60 (85%) of the vendors operated from stalls along the streets, while only 11(15%) of those surveyed were mobile. About 27 (38%) food vendors surveyed told that they prepared the food at their home and sold at the stalls while 44(62%) cook the food at the stall. Knowledge about food vending was acquired by self-teaching, in 50(70%) of the street vendors while 21(30%) of them acquired their knowledge via observation or were taught by their parents. No one of the vendors surveyed participated formal training in food handling and vending. All vendors in the study area adapted traditional methods to cook the food (table 2). Muinde and Kuria [18] reported that most (61%) of the vendors in Nairobi acquired cooking skills from observation, 33.3% were taught by their parents, while 6.3% gained the skills through trial and error (self-taught).

### 2. Knowledge and Practice of Street Food Vendors about Food Handling

Thirty seven (52%) the vendors admitted that they washed food before cooking. The preparation surfaces were dirty in 90% of those surveyed. Forty eight (48%) vendors claimed that they washed the preparation surface before reuse, while 75% of them reused oil for frying. It had been observed that all of the vendors prepared food in unhygienic conditions.

Hygiene in handling and cooking of street foods is very important. According to FAO [19], food handlers should have the necessary knowledge and skills to handle food hygienically. From this study, it has been observed that all of the vendors prepared food in unhygienic conditions. This study indicated that the health risks of consuming street foods are high, that street food vendors depend on vending for their livelihood and that their customers depreciate their trade. The study in Nairobi reported that about 85% of the vendors prepared their foods in unhygienic conditions [18]. Many studies have reported that due to lack of proper knowledge and guidance on street food vending, vendors prepared their foods in explicitly unhygienic and unsanitary conditions which is common practice in developing country.

Food safety also largely depends on personal hygiene. Personal hygiene is important because human beings are the largest sources of food contamination. Handling with bare hands may result in cross-contamination, hence introduction of microbes on safe food. From the present study, it has been found that no one vendors used apron while cooking or serving food, all handled food with bare hands and wore hair covering. It was observed that all the respondents handle money while serving foods. Food was mainly served in metal plates (78%). All of them stored their food in covered warmers or utensils, none of them could afford storage in refrigerators



when electric is available. This is in line with the findings by Muinde and Kuria [18] in Niarobi where they found that 81.3% of the vendors did not use aprons, 60% handled food with their bare hands and 65% had no hair cover. All their vendors handled money while serving food and only 10% of them wore jewelry. About 21.2% of the street food vendors stored food for serving openly in stalls, while 9% stored them in wheelbarrows. About 82% had leftover for next-day serving and none of the vendors had refrigerators for storage.

### 3. Microbial Profile of Vended Street Food in Mahendranagar

Based on personal observations and interviews with the producers, consumers, and sellers engaged in the production of the street foods, the methods of preparation and varieties of ethnic street foods were summarized in Tables 1. Various street foods are sold in Mahendranagar which include samosa, alu chop, momo (vegetable, chicken, mutton), alu-cheura, chowmein (vegetable, chicken, mutton, egg), alu tikki, bread chop, vegetable pakoda, panipuri. The vendors prepare foods locally at their homes and the foods are sold in the streets, public places, busy market places, school areas, near college campuses, and bus park etc. A total of 71 samples of street foods were collected from Mahendranagar were analyzed to determine the microbial load expressed in log cfu/g depicted in table 3.

All the samples showed high total viable count ranging  $10^6$  cfu/g to  $10^8$  cfu/g, which is unsatisfactory level. The high total aerobic plate counts indicated poor general quality of the street vended foods. The results of this study clearly demonstrated that the street-vended foods in Mahendranagar were contaminated with different pathogenic bacteria. The existence of these bacteria in foods could induce potential health problems for consumers. Poor personal hygiene,

improper handling and storage practice of foods and poor knowledge of food vendors about food borne disease may be the associated risk factors to contamination of street vended foods. Contamination of street vended foods could result from pre-or post-cooking contamination from the food handlers. Street food vendors are often unlicensed, untrained in food safety, food hygiene and sanitation, and they work under crude unclean conditions [18].

LAB was detected up to the level of  $10^5$ cfu/g. Based on their detailed characteristics and identification profiles(data not shown), the following genera and species of LAB isolated from various street foods of Mahendranagar were identified as *Lactococcus lactis*, *Lactobacillus plantarum*, *Lactobacillus brevis*, and *Enterococcus faecium*. Spore forming rod-shaped bacteria from street foods were identified as *Bacillus subtilis*, *Bacillus pumilus*, *Bacillus lichen*, and *Bacillus cereus* (not shown in table). The predominance of *Bacillus* spp. was possibly due to the presence of spores in the raw materials which may have survived cooking [20]. High prevalence of *Bacillus* species upto  $10^7$  cfu/g in street foods in this study was similar to that reported from street foods (panipuri, dahibara, and chaat) of Baripada town in Odisha state of India [21, 22].

In this study, the level of coliforms varied between  $10^2$  cfu/g to  $10^5$  cfu/g, which is above the acceptable levels and may prove to be hazardous to human health and were higher than the work conducted in Tirumala [23] with the reported finding of  $0.28-3.99 \times 10^3$ cfu/g. The presence of total coliform in street vended foods can be linked to contamination resulting from inappropriate processing, incomplete heating, uses of contaminated water during preparation and washing or secondary contamination via contact with contaminated materials such as chopping boards, knives and

serving wares [24]. *Enterobacteriaceae* were detected in all of the food samples which were also above than acceptable level. This detection rate was consistent with a previous study carried out in Amravati City, which reported finding of 92% of all food samples [25]. The presence of *Enterobacteriaceae* in this study might be attributed to the heat processing failure or post-processing contamination, faecal contamination and poor hygienic practice of food handlers [26]. One major source of contamination of foods sold by street vendors is the water used for washing and processing [27].

We found the prevalence of *S. aureus* in range of  $10^3$  - $10^5$  cfu/g in all food except alu tika but vegetable momo and vegetable chicken had very low count which is at the marginal level of acceptable limits. There was low contaminant bacteria count in vegetable chowmein, vegetable momo and alutika. In our finding the food sample like somasa, chicken momo, chicken chawmein, aluchopand panipuri, the load of *Staphylococcus aureus* were exceeding than acceptance level which similar finding of the [21]. The presence of *S. aureus* was an indication of contamination from the skin, mouth or nose of food handlers through coughing and sneezing. This contamination can be introduced into the street foods during handling, processing or vending [27]. The highest total *Staphylococcus* counts were found in panipuri, it may be attributed to totally unhygienic handling by the vendors. A high number of *S. aureus* may result in the production of enterotoxins causing food-borne diseases. Strains of *S. aureus* isolated from street foods showed hemolytic and coagulase activities, while other strains of *Staphylococcus* spp. show negative results. The level of coagulase positive *S. aureus* is considered potentially hazardous at greater

than or equal to  $10^4$  cfu/g, and may even lead to food-borne illness [28].

In this study, *Salmonella* spp found unsatisfactory level was  $10^3$  cfu/g in chicken momo and also reported in somasa. This is similar to previous works done on 'Gangtok' and 'Nainital' in India [21]. Usually, it is difficult to predict the association of *Salmonella* spp with specific food products. However, in some situations, the *S. enteritidis*, can be associated with beef, meat, milk poultry and eggs or egg products [29]. The presence of *Salmonella* spp. might be due to the difference in the ingredients in that the foods in this study included animal products. The presence of *Salmonella* Spp. in these foods is attributed to inadequate sanitation and poor personal hygiene. Although raw eggs and egg products have been implicated in contamination with *Salmonella enteritidis*, the ability of this pathogen to survive for up to 7–14 days on the surface of many fresh fruits as in melons has been reported.

Food-borne bacterial pathogens commonly detected in street vended foods are *B. cereus*, *Clostridium perfringens*, *S. aureus*, and *Salmonella* spp. [17, 30]. *Escherichia coli* frequently contaminates items and is often considered a good indicator of fecal pollution *Escherichia coli*, *Salmonella* spp., and *S. aureus* were reported in some common street foods such as pakoda, kachori, and samosa of India [31].

In the present study yeast isolated from street foods were identified as *Saccharomyces cerevisiae* and *Pichia burtonii*. Molds were not recovered in any sample examined. The lesser levels of yeast and the total absence of mold in all food samples tested could be due to the time and temperature exposure for the steaming/frying/cooking processes. This could be related to the similar finding on the study

conducted on Gangtok and Nainital of India [32].

### CONCLUSION:

The results of this study clearly demonstrated that the street-vended foods in Mahendranagar were contaminated with different pathogenic bacteria. The existence of these bacteria in foods could induce potential health problems for consumers. Poor personal hygiene, improper handling and storage practice of foods and poor knowledge of food vendors about food borne disease were the associated risk factors to contamination of street vended foods in Mahendranagar. This study revealed that almost all the samples are unacceptable microbiologically and safety levels. The situation calls for formulation of strict public-health regulations regarding the sale of street foods in these particularities. Therefore, consumption of such contaminated street vended foods poses a serious problem to community health. These provide information for responsible organizations to take actions to provide regular training and to create awareness on food handling and personal hygiene among street food vendors as well as consumers. Governments should invest more in basic social services such as water supply, electricity and education for food vender of street food sector.

### Conflicts of Interest

All authors have no conflicts of interest to declare.

### Dedication

This research article is prepared to dedicate for condolence of my late mother Nanda Devi Bohara who left us on 23 August 2017.

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